NASA Observations and Modeling during ICE-POP

Walt Petersen
NASA GPM Deputy Project Scientist, GV
NASA Marshall Space Flight Center

David Wolff
NASA GPM GV Systems Manager
NASA Goddard Space Flight Center

V.Chandrasekar, CSU
J. Roberts, MSFC,
J. Case, MSFC/ENSCO

KMA ICE-POP Meeting
27-30 November 2018

Broader Framework for NASA Involvement in ICE-POP

Programmatic Focus

- NASA Weather Program, Short Term Prediction and Operational Research Transition Center (SPoRT)
- NASA's Global Precipitation Measurement (GPM) Mission Ground Validation and Precipitation Measurement Mission Programs

NASA Multi-Center Team in ICE-POP

- MSFC, GSFC, WFF (+CSU)

Overarching Objective:

- Leverage international collaboration and synergistic observational (GPM- MSFC/WFF/CSU), numerical modeling (MSFC-SPoRT/GSFC), and research transition (MSFC-SPoRT) opportunity to verify, test utility, improve satellite products and numerical prediction models in heavy orographic snow regime

Recap: NASA-Specific Objectives for ICE-POP

Provide real-time observational and NWP data in support of ICE-POP, participate in significant international science effort.

GPM Ground Validation and NASA Weather Program:

- Direct/physical validation of active/passive satellite-based snowfall retrieval algorithms over coastline and mountains; melting layer interaction with terrain
- Physics of snow, coupling to snow water equivalent rate and satellite remote sensor retrieval algorithm assumptions
  - Size distributions, types/habit, water equivalent, profiles
- NUWRF Model + Observational analyses: Movement toward “level IV products” leverage intensive and multi-faceted NWP component.
- Model precipitation processes (liquid, mixed phase and frozen); Build model testing database for further active/passive remote sensing algorithm development (e.g., satellite data simulators)
- "Integrated" validation of products in operational context

NASA Instruments in ICE-POP: D3R, PIP, Pluvio, MRR

Dual Frequency Dual Polarimetric Doppler Radar (D3R)

Precipitation Imaging Package (PIP) x 2 (imager/disdrometer)

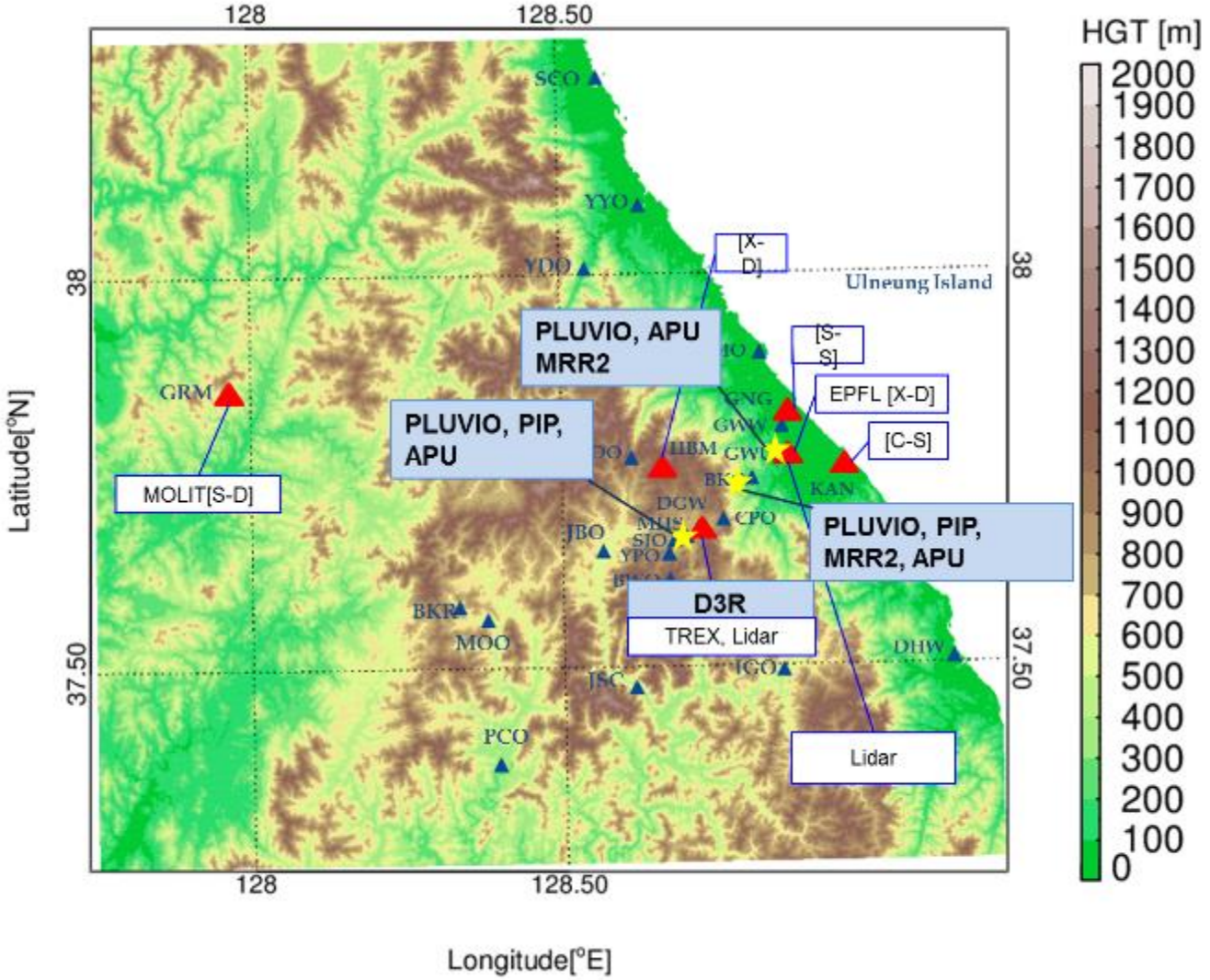
MRR x 2

Pluvio$_2$ x 3

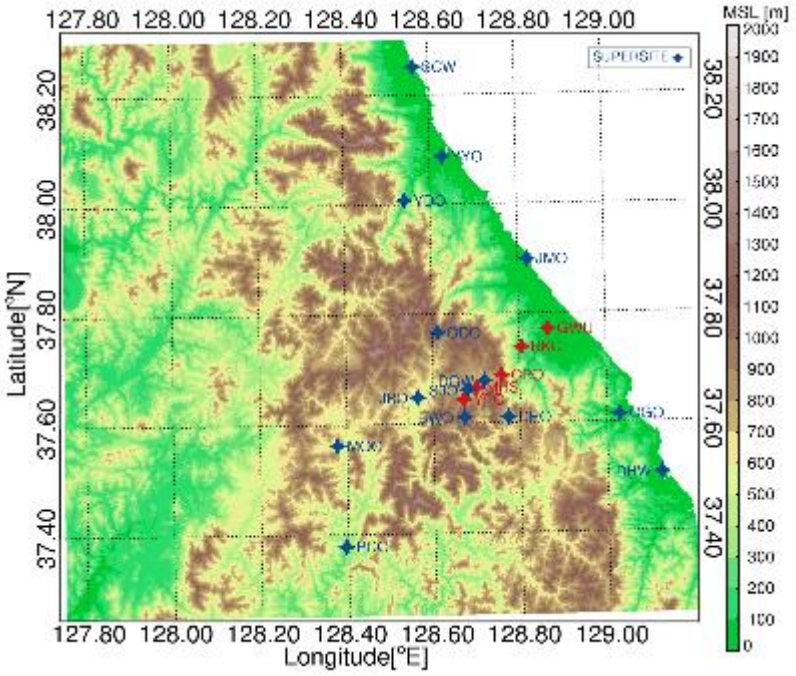
Parsivel disdrometer (APU) x 3

GLOBAL PRECIPITATION MEASUREMENT

NASA Instruments in Broader Network



Disdrometer and Pluvio Network: NASA-Processed



- ***Processing for rain and snow, Nov 17 - April 18***

PARSIVEL Network (11/2017-04/2018)

3 NASA (GWU(APU09), BKC (APU13), MHS(APU14))

7 NIMS (JPO, DRO, CPO, YPO, ODO, BW0, SJO)

1 KNU (MHS)

1 CCU (PCO)

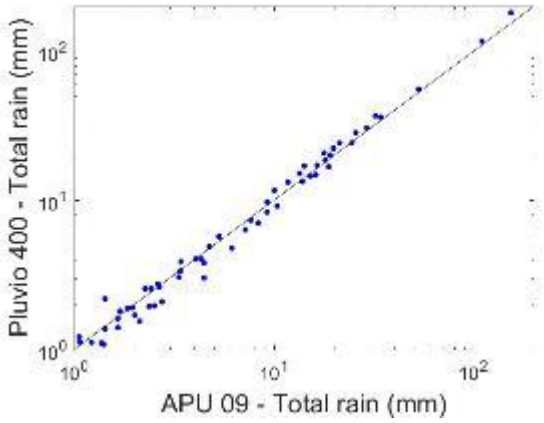
8 UCLM (MOO, DGW, SCW, YYO, YDO, JMO, OGO, DHW)

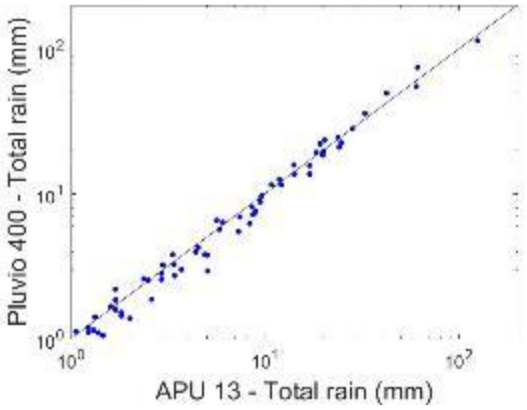
PLUVIO 400/200 Network (11/2017-04/2018)

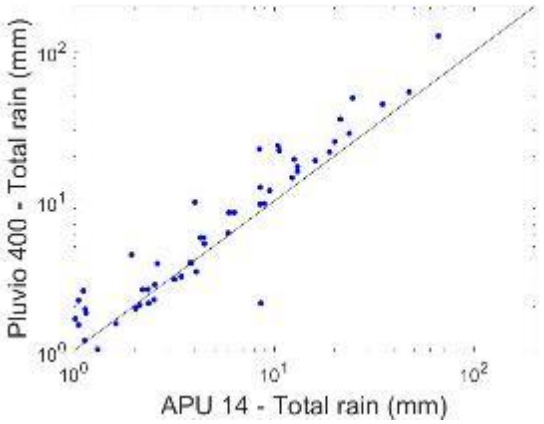
3 NASA (GWU, BKC, MHS)

1 KNU (YPO)

Event rain comparisons for EOP







Contact: Ali Tokay, ali.tokay-1@nasa.gov

D3R: Scanning Changes due to Mechanical Issues

Prior to 2/12/2018 (Slip ring problem)

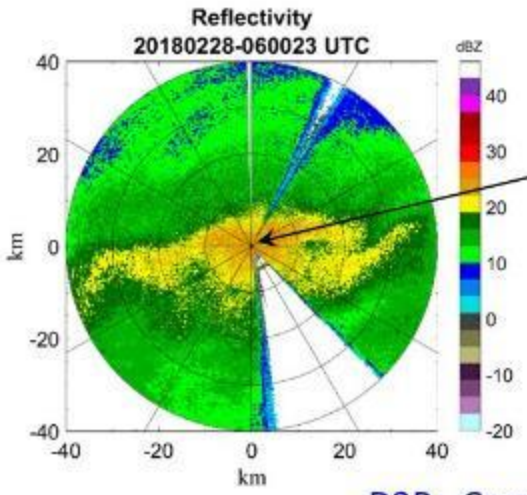
Scan	Azimuth (degrees)	Elevation (degrees)	Scan Rate (deg/sec)	Samples	Azimuthal Resolution (degrees)	Site Name	Time taken for scan (seconds)
RHI	51.31	0 to 90	3	128	0.192	GWU-1	30
RHI	231.54	0 to 90	3	128	0.192	MHS	30
PPI	0 to 359	4	14	128	0.896		25.72
PPI	0 to 359	5	14	128	0.896		25.72
PPI	0 to 359	6	14	128	0.896		25.72
PPI	0 to 359	7	14	128	0.896		25.72
PPI	0 to 359	8	14	128	0.896		25.72
RHI	330	0 to 90	3	128	0.192	HBM*	30
Birdbath	0 to 359	90	8	128	0.512		45
							Total: 263.6

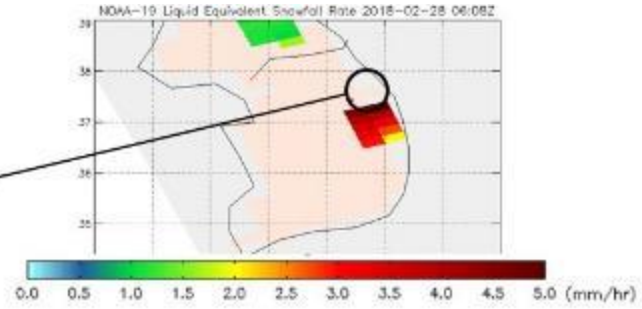
2/12/2018 to 3/12 (then down)

Scan	Azimuth (degrees)	Elevation (degrees)	Scan Rate (deg/sec)	Samples	Azimuthal Resolution (degrees)	Site Name	Time taken for scan (seconds)
RHI	51.4	0 to 90	3	128	0.192	GWU-1	30
RHI	231.4	0 to 90	3	128	0.192	MHS	30
RHI	330.5	0 to 90	3	128	0.192	HBM*	30
PPI	0 to 359	5	14	128	0.896		25.7
							Total: 115.7**

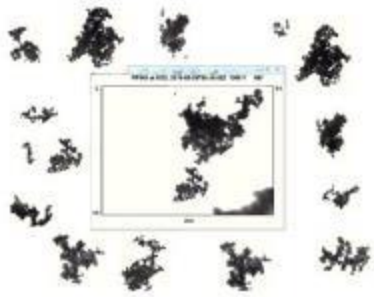
Example Observations from ICE-POP

28 February Heavy Snow Event



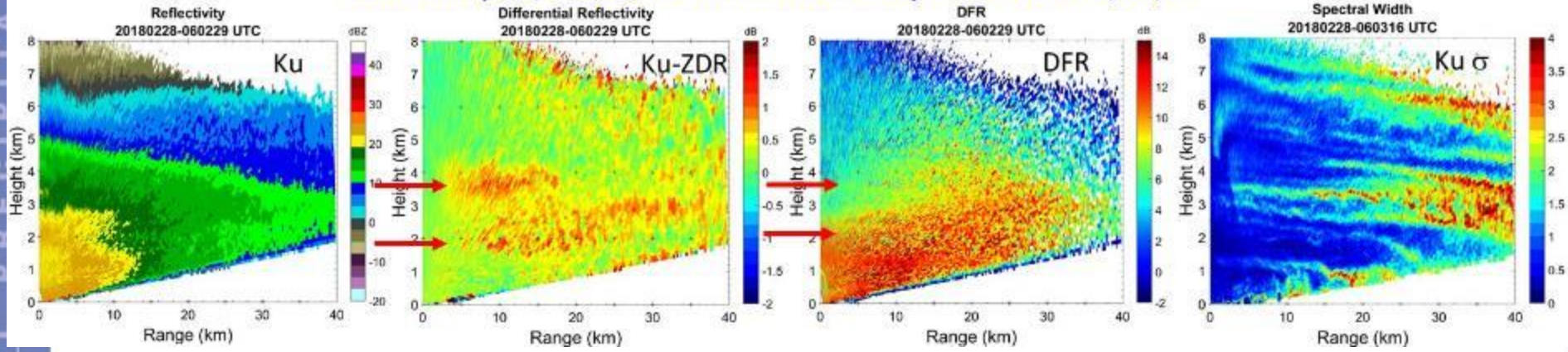


NESDIS SFR Algorithm (MHS; NOAA 19)
Snowfall rates consistent with KMA radar and PIP (4-6 mm/hr)- but south. (GFS- issue!)



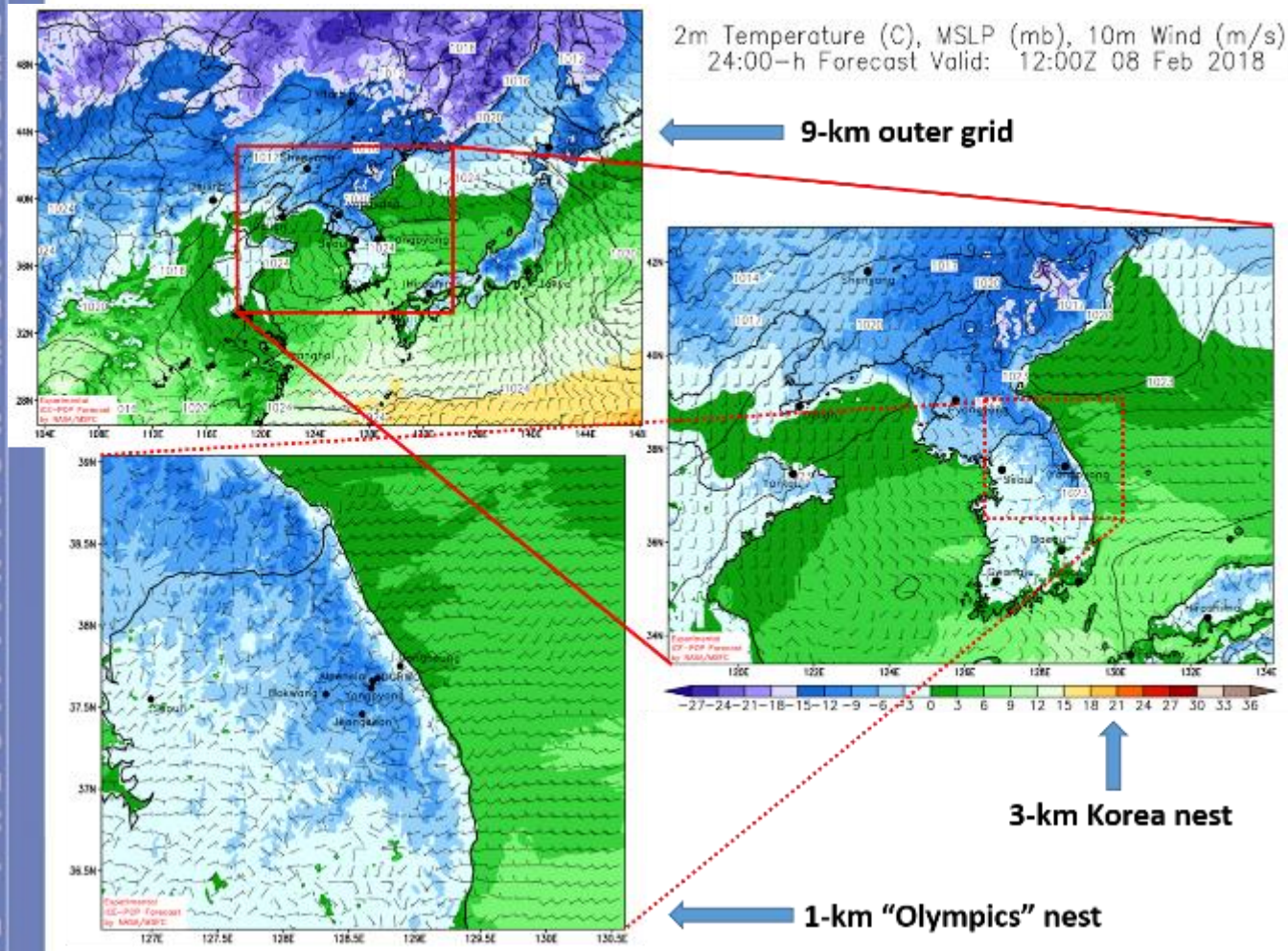
PIP 0556 UTC: Large Aggregates (largest ~2.5 mm)

D3R: Complex, turbulence-enhanced heavy snow event 2/28/18



Data note: 13 dB Ka-Correction applied due to snow on radome

NASA Unified-WRF Modeling Component



NASA Unified-WRF (NU-WRF) Model Features:

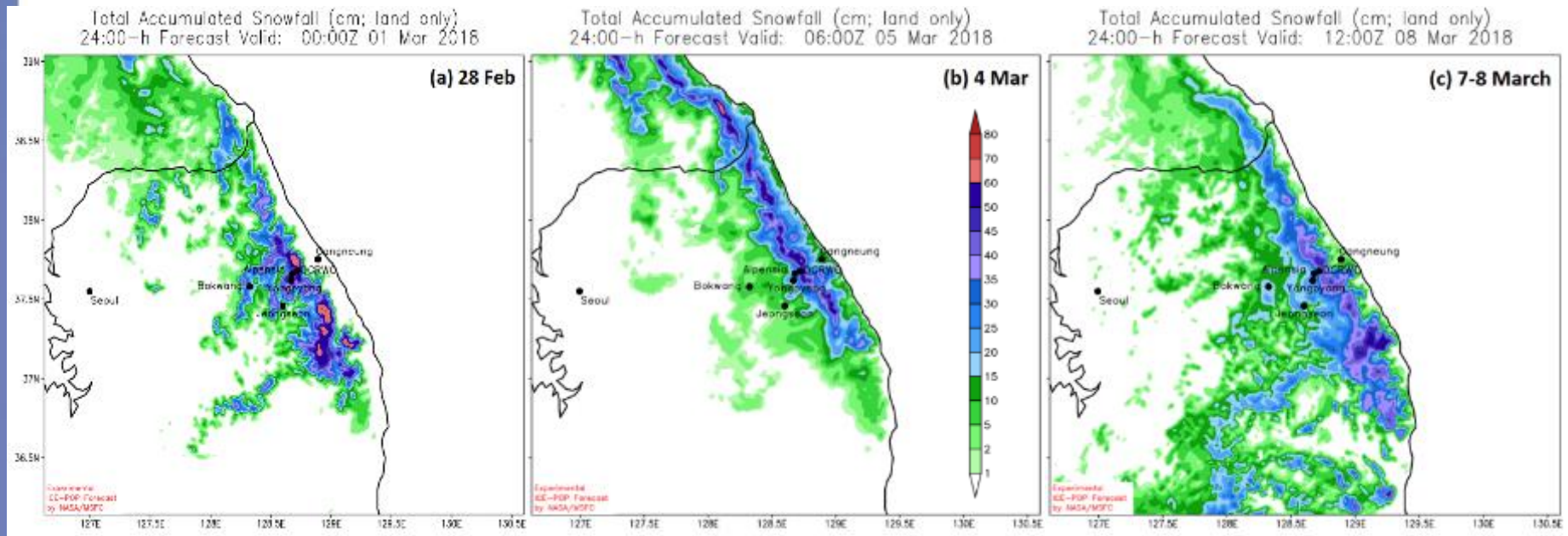
- 4x daily 24-hour forecasts
- Initialized 00/06/12/18z
- 30 minute output
- 62 vertical levels
- PBL: MYJ; LSM: Noah
- SW/LW Radiation: NASA/GSFC schemes within NU-WRF
- Microphysics: NASA/GSFC 4-ice graupel+hail
- Cumulus: Grell-Freitas (9km only)
- ICs/BCs: NCEP/EMC GFS
- SSTs: 2-km NASA SPoRT MODIS+VIIRS product

Model grids uploaded to KMA in real-time during experiment

GLOBAL PRECIPITATION MEASUREMENT

Observations and Simulations from High-Impact Events

Example: Three Significant Snowstorms between Olympics (Feb) and Paralympics (Mar)



Twenty four-hour simulated snow accumulation [in cm] from the NU-WRF 1-km grid for snowstorm events on (a) 28 February, (b) 4 March, and (c) 7-8 March 2018.

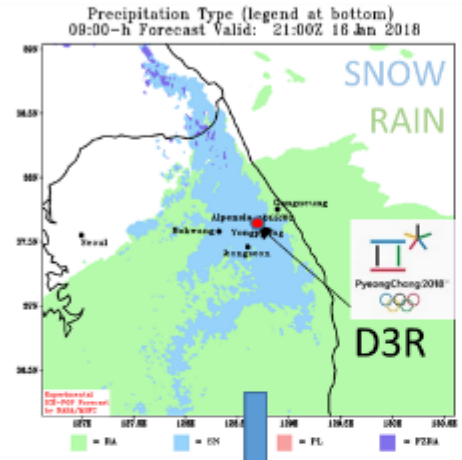
Early ICE-POP: NU-WRF, GPM, and ICE-POP Observations

GLOBAL PRECIPITATION MEASUREMENT

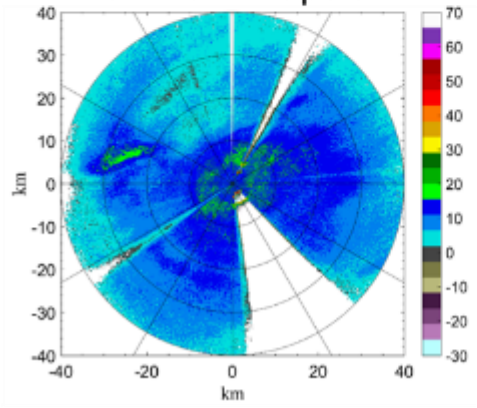
January 17, 2018

Precipitation Type (Rain or Snow)

Forecast is Snow

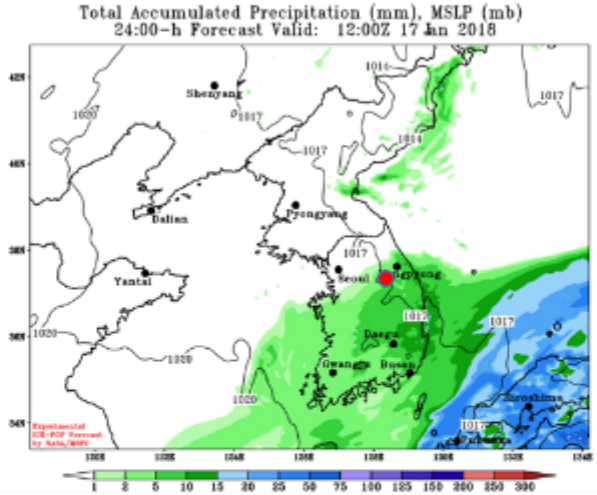


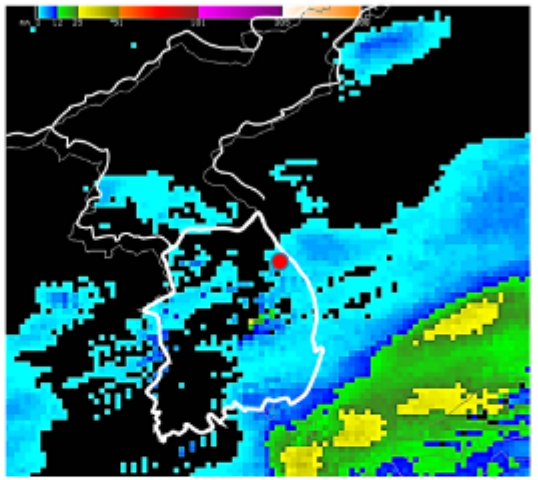
NASA D3R Maps Snow



Precipitation Amount (24-hr estimate)

Forecast is for 2-5 mm → IMERG Estimates 1-2 mm





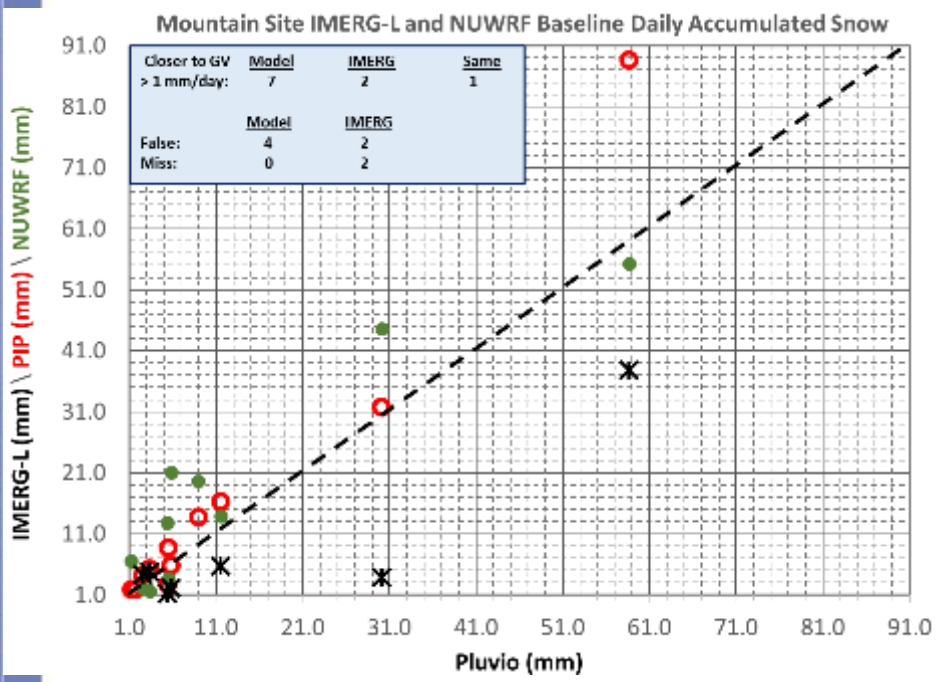
NASA and KMA ground-based observations measure ~1.5 mm

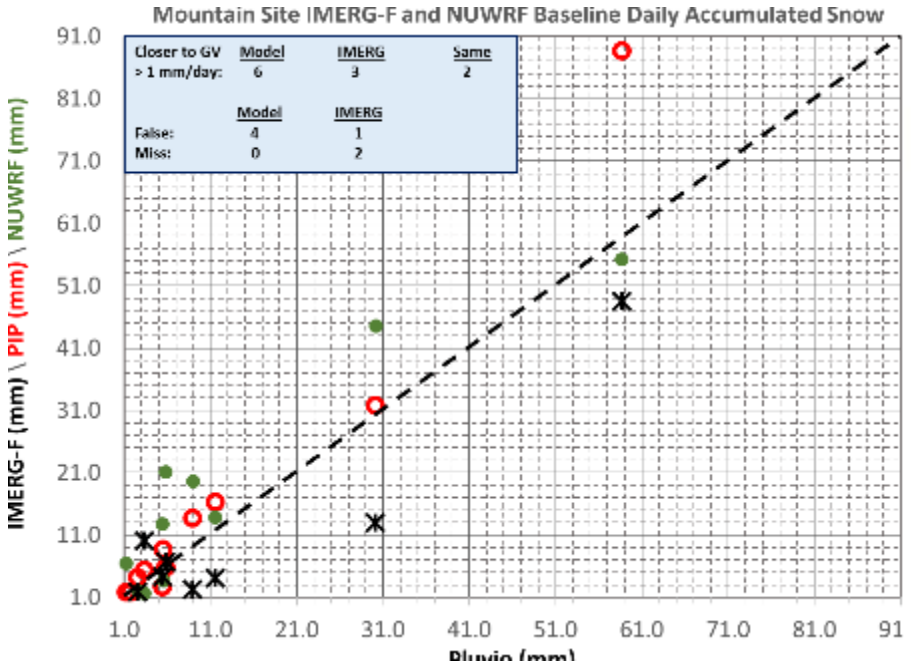
Forecast, GPM IMERG, and ICE-POP observations agree on precipitation type and amount for an early ICE-POP snow event near PyeongChang.

These comparisons will continue as ICE-POP progresses

ICE-POP Snowfall for the Campaign

How do IMERG and NUWRF Perform Relative to Surface Obs (GV) for Estimating/Predicting Daily Snow Water Accumulation?





NUWRF (baseline) PIP (mm/day) IMERG (mm/day)

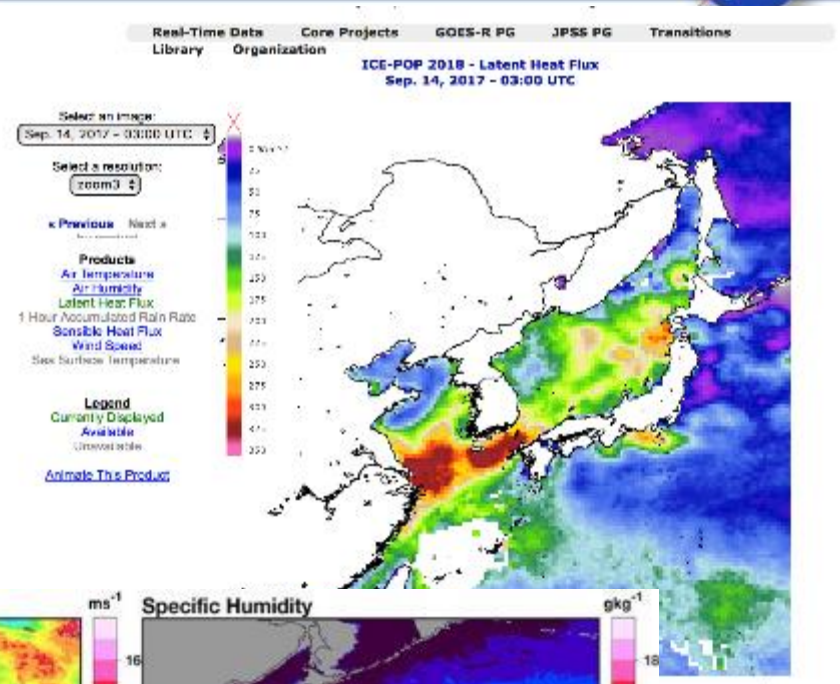
- Baseline NUWRF 24-hour forecast accumulation does as well or better than IMERG*.
- ***Caveat***- Model had more false alarms; IMERG more misses

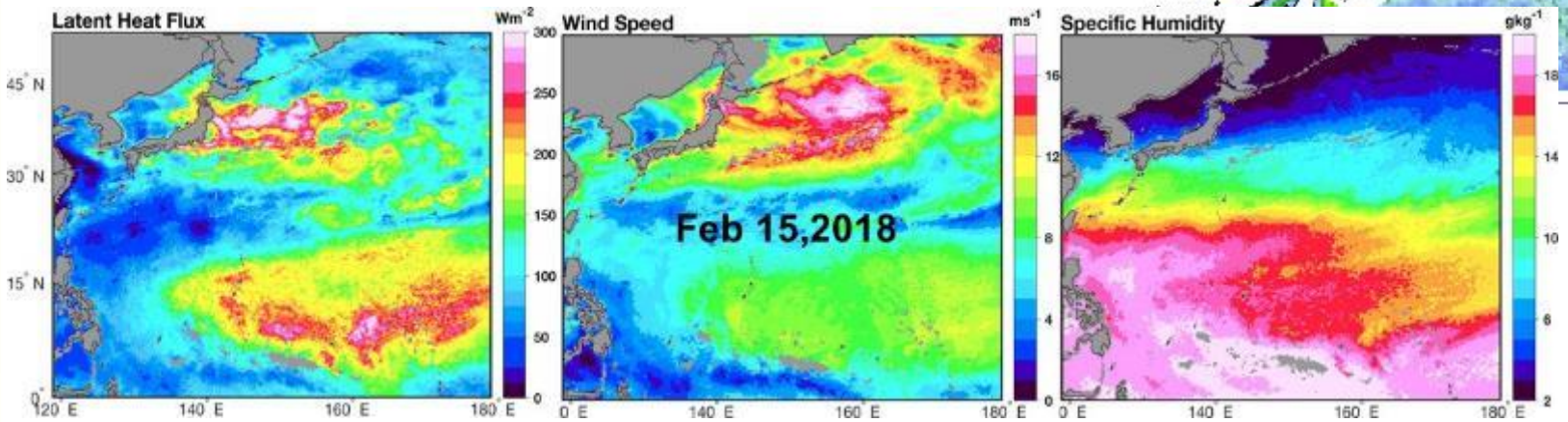
ICE-POP: Real-time Ocean Turbulent Heat Fluxes

Objectives:

Leverage GPM microwave imagers to generate real-time ocean turbulent heat flux dataset (T/Q/Wind); subsequent global archive.

Data Assimilation testing for ICE-POP NWP





- ***Global** , 25km archive generated for the GPM-Era (Feb. 2014 - Mar. 2018)*
  - *Swath level (L2) surface meteorology*
    - ***GMI, AMSR-2, SSMIS (F16, F17, F18, F19)***
  - Hourly, gridded (L3) meteorology and turbulent heat fluxes
- Data are/were made available through web server and visualizations in real-time

GLOBAL PRECIPITATION MEASUREMENT

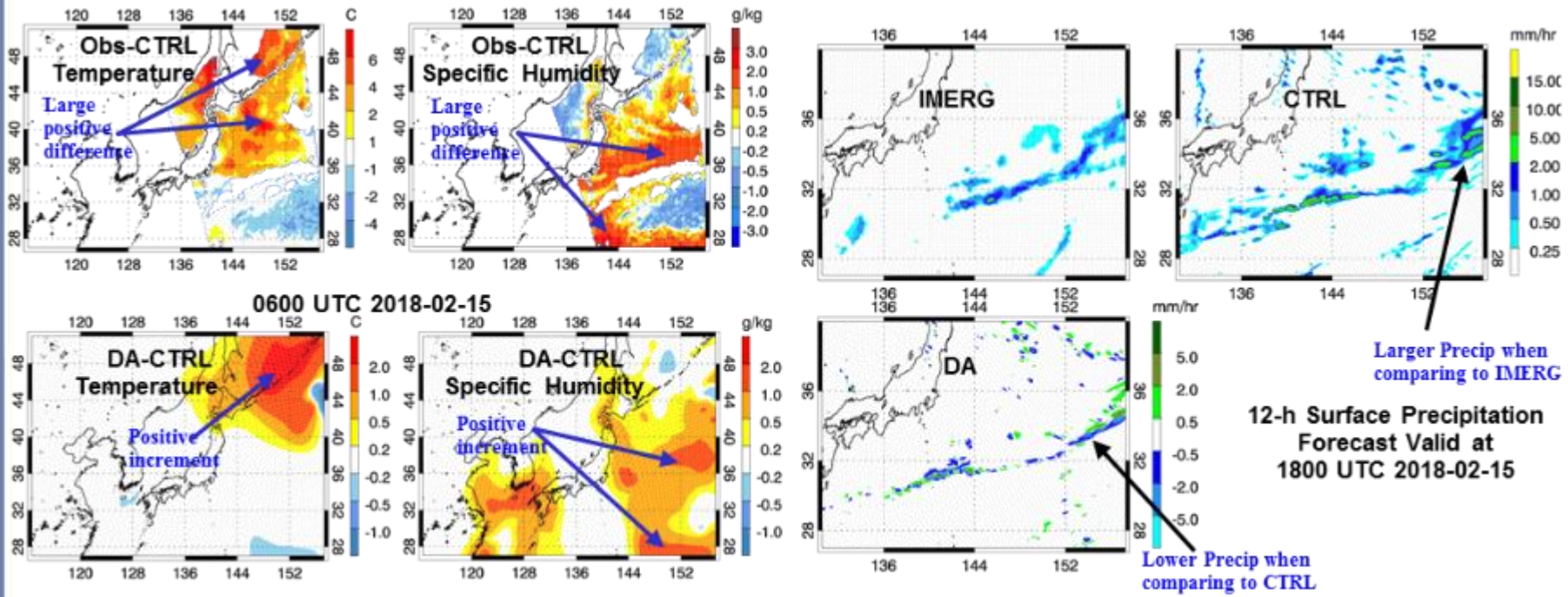
Preliminary Assimilation Tests of T/Q/Wind Data

Objectives: Assimilate surface temperature, moisture, and wind speed products retrieved from GPM L1C data; Assess impacts on snow storm events observed during ICE-POP.

Approach: WRF model with 9 km + 3 km resolution and 62 vertical levels; Community GSI v3.6.

Cases: TEST 15-17 February 2018 Japan (currently completed 2 DA cycles, working on 6 more DA cycles available at later times); 27-28 February 2018, 4-5 March 2018 .

Impact: Preliminary result indicates an increment of ~2° C in low level temperature and 1-2 g/kg in moisture field. Impact on precipitation forecast is also found.



X. Li and J. Roberts

Summary

Data

- Dataset(s) successfully collected and generally are quite robust (D3R mechanical issue, occasional Pluvio capping/hysteresis etc.)
- Many GPM overpasses of domain during IOP (primarily passive microwave, limited DPR)
- Observational inventory (QC) uploaded, satellite products (available via NASA DAAC-can make subsets for ICE-POP), surface parameters (LH/SH fluxes), high resolution SST, NUWRF FDP model products also uploaded.
  - Some issues with instrumentation noted (D3R, Pluvios)
  - Action: need to ensure data repository is complete, inventoried/documented properly, final QC versions.

Science:

- Direct/physical validation of satellite-based snowfall retrievals over complex terrain underway
- Preliminary looks at snow physics, cloud model ice processes
- Preliminary data assimilation testing underway
- Limited presentations at AMS Wea. Fcstg., ERAD, PMM Science Team etc.